DOCUMENT RESUME

ED 154 776 IR 005 758

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TITLE Draft of the University of Chattanooga Foundation Academic Use Computer Study Report. Volume I, Summary and Recommendations. Volume II, Analysis, Findings, and Recommendations.
INSTITUTION Tennessee Univ., Chattanooga.
PUB DATE 76
NOTE 62p.; Parts may reproduce poorly due tc paper and ink color contrast

EDRS PRICE MF-$0.83 HC-$3.50 Plus Postage.
DESCRIPTORS Computer Assisted Instruction; *Computer Oriented Programs; *Computers; Educational Finance; *Educational Planning; Educational Technology; *Higher Education; Instructional Technology; *Needs Assessment; Planning; Time Sharing

ABSTRACT

A study was conducted in 1974 to assess the state of academic computer use both at the national level and at the University of Tennessee at Chattanooga (UTC), and to recommend strategies for the development and maintenance of quality computing facilities at UTC. The report summarizes findings collected during faculty surveys, discussions with consultants, and meetings with vendors. Volume I contains a summary and recommendations relating to computer needs at the University. Volume II contains the analysis, findings, and more detailed recommendations. Appended are specifications for a Time Sharing Computer System for the Academic Computer Center at UTC. (Author/STS)

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DRAFT OF THE

UNIVERSITY OF CHATTANOOGA FOUNDATION

ACADEMIC USE COMPUTER STUDY

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Academic Computing Services - UTC

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

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VOLUME I

SUMMARY AND RECOMMENDATIONS

The University of Chattanooga Foundation established the Academic Computer Study Advisory Committee to investigate the present state of academic computer usage both on the national level and at the University of Tennessee at Chattanooga, and to recommend to the Chancellor strategies for the development and maintenance of quality computing facilities at the Chattanooga campus. To this end, committee members visited ten campuses, attended four conventions, and brought eleven consultants to the campus. Information from these sources was augmented by student and faculty attitudinal surveys, by discussions with concerned students, faculty, and administrators, and by lengthy deliberations by the entire committee. Over the eight month investigative period, the committee solicited and weighed advice from all the constituencies of the university.

The Chattanooga campus has a medium-sized IBM 360/30 computer that is primarily used for administrative computing, such as student registration, mailings, grade reports, and other staff duties. This machine has recently been linked with a larger IBM 360/65 computer located at Knoxville to give the campus additional facilities, particularly for the manipulation of large amounts of data. The Engineering and Psychology departments also have their own "minicomputers" for laboratory work. The computer center, located in the basement of Hunter Hall, has a small staff consisting of a Director, an Assistant Director, four programmers, keypunch operators, and student help. Because of the heavy administrative load, however, the staff is not generally available to aid students and faculty with their instruction and research.

Problems arising from machinery and staff limitations are aggravated by the fact that the computer has demonstrated its value for educational functions far broader than merely performing the university's routine bookkeeping tasks.

On a national level the philosophy that all students should be exposed to the computer's possibilities as well as its limitations is rapidly gaining credence. This generation of students will live, reason, and work in a society increasingly computer oriented and hence a university has the responsibility to prepare its graduates for this world. Imaginative educators, however, capitalizing upon recent technological advances have developed techniques to functionally integrate computing into the undergraduate curriculum. The student no longer need learn computing, as one learns irregular verbs, but rather may use the machine to solve complex classroom problems thereby assimilating a feel for the computing processes as well as a practical appreciation for the realities of man interacting with a machine.

Chief among recent innovations has been the growth of "interactive" computing, a man-machine relationship whereby the user, seated at a typewriter with either a paper print out or before a keyboard with a cathode ray tube much like a television screen, actually "talks" to the computer by typing in messages in standard English. The computer, able to handle dozens of such communications simultaneously, quickly responds to the user - hence the interaction, negating the need for punched cards. Interactive computing's versatility, portability, and rapidity have opened whole new educational vistas, the most promising being "computer aided instruction," (CAI). Sophisticated CAI programs, operating in numerous universities, run the gamut from routine practice drills to polish the student's basic skills, to complex simulations that challenge students to manipulate numerous variables with the full understanding that, just as in real life, they can alter the configuration of the entire model. Students using interactive computing can test themselves, calling forth questions from large "test banks" entered into the computer by the instructor, until they have mastered the course materials. Paradoxically, interactive computing allows a student (from the slowest to the most advanced),

a great deal more individualized instruction than he is likely to receive from an overworked and perhaps impatient instructor. Moreover, when interactive computing capabilities are harnessed to a machine capable of storing large amounts of data the whole process is exponentially enhanced. Numerous disciplines such as Business Administration, Political Science, Sociology, History, Economics, and others,require such capabilities to enable the students and faculty members to do meaningful research.

Consultants, interviews, and surveys all indicate that there exists at the University of Tennessee at Chattanooga a significant demand for interactive computing for instructional and research purposes. Students and faculty alike agree that computer knowledge and experience is desirable for graduates in all disciplines, but perhaps more so for those in the natural sciences, the behavioral sciences, and business and economics. More importantly, there is a desire, if surveys and interviews can be trusted, on the part of students and faculty to adapt the computer's possibilities to the instructional process.

What is lacking at the Chattanooga campus is the necessary equipment and staff. The IBM 360/30 cannot be adapted for interactive computing without expensive alterations and even then the machine is inherently too slow to do an optimal job. The Knoxville 360/65 can handle interactive computing but the telephone and user charges are prohibitive, as is the purchase of another large general purpose computer for this campus. Moreover, after a central machine is obtained that can drive the remote-entry terminals, the question remains of what type terminals are desirable, typewriters with printed output, keyboard and cathode ray tubes, or plotters that will draw graphs, lines, pictures, and will project them to a large screen for classroom use.

Staffing needs for academic computing materially differ from those required in a more traditional computer center by the very nature of the constituency they serve. Academic computing will not succeed without the support and

cooperation of faculty willing to introduce the concept into their courses. Hence there is a vital need for workshops to train faculty members in a simple program language to enable them to originate programs suitable for use in their classes and to provide advice on the techniques that are most successful. If the faculty are not enthused, their students will not be motivated to experience the computer's full potential. An academic computer coordinator must therefore be knowledgable about academic computing elsewhere, (perhaps through university membership in a national academic computing organization such as CONDUIT), tactful, technically resourceful, and fully supported by his administrative superiors to make the program successful.

To bring the facilities at the University of Tennessee at Chattanooga up to date and to provide an adequate level of academic computing, the committee recommends that the university purchase 32 terminals; 15 typewriters, 15 cathode ray tubes, and 2 graphics, at a cost of $39,000, to be located throughout the campus for the student's convenience. The most economical method for providing the computing capabilities necessary to make academic computing a reality would be to purchase a minicomputer such as the Digital Equipment Corporation's PDP-11 or the Hewlett Packard Company's 2000G at a cost of $97,500. This machine can drive 32 interactive terminals and simultaneously route punch card computing jobs to Knoxville's 360/65 to be run. See Appendix A of Volume II for detailed specifications. To speed up research that uses a large number of printed cards, the committee suggests the purchase of a card reader and line printer for $14,000 to provide continuous rather than the present intermittent connection with the Knoxville computer. Minimal staffing requirements for a concerted academic computing effort with a series of faculty workshops will cost about $5,000.

While the items above form an acceptable facility for the initiation of academic computing at the University of Tennessee at Chattanooga, additional levels of staffing might be funded to strengthen the prospects at the outset.

For those faculty members who will make the heaviest use of the facilities, overload pay, travel allowances, and perhaps released time would be desirable for a period of two years. For approximately 20 faculty annually this would entail a yearly expense of $12,500. An economical method of obtaining responsible leadership would be to award a qualified faculty member a half-time appointment as part time coordinator, which with student help would amount to $12,000 per year for two years. The most satisfactory arrangement would be the employment of a full-time Academic Computing Coordinator who, with secretarial help, would constitute a permanent yearly university commitment to computing in particular and to the quality of education at the University of Tennessee at Chattanooga in general.

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ACADEMIC COMPUTER STUDY REPORT

Prepared By:

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VOLUME II

ANALYSIS, FINDINGS, AND RECOMMENDATIONS

INTRODUCTION

If the overriding purpose of any university is to transmit to future generations society's cumulative knowledge and to prepare them to build upon that wisdom, then it is imperative that education must be receptive to adaptation to meet the future needs of the community it serves. A major factor contributing to recent social change has been the advent and the maturation of the computer. This versatile tool, so indispensible to modern society, also offers widely recognized educational benefits to the university community. Computing is rapidly becoming as essential for a sound curriculum as the college library; both, in fact, are information repositories differing principally in their methods of data manipulation and retrieval. For the first time, using current computer technology, undergraduates can readily surpass the usual limitations on the decision making process imposed by time, limited information, and economics, and focus instead upon broad strategies and techniques. The very scope of the machine's problem-solving capabilities broadens student horizons and adds an element of excitement and adventure to the intellectual process. Moreover, as a teaching supplement, the computer has proven capable of performing myriad tasks from drilling fundamentals to posing complex probabilities for students on a "personal" basis.

The inherent advantages of modern computer facilities present a university with both problems and opportunities. The primary problems are the initial cost and the difficulty of tailoring a system to meet broad educational needs. When overcome, however, the resultant facilities help to attract outstanding students, especially those in disciplines, including most of the professions which are heavily dependent upon quality computer facilities. Similarly, distinguished faculty in such fields seek to affiliate with universities possessing strong computer capabilities. Even outside the areas that traditionally make

heavy use of the computer, such excellent facilities can be of immeasurable value. The social sciences and the humanities in the last few years have widely expanded their use of such systems, with fascinating results in diverse areas from determining who "really" wrote Shakespeare's plays to criminology.

The University of Tennessee at Chattanooga's institutional goals statement of February 24, 1975 effectively demonstrates the advantages of a modern academic computing system and points up the need for such improved services within the university. Of the fourteen specific goals in that statement, efficient computer facilities would contribute to the realization of at least thirteen. A strong academic computing program, as Dartmouth College has proven, attracts new students and students of superior ability and motivation. Programs in all of Chattanooga's disciplines will be strengthened by the introduction of updated equipment, providing additional educational opportunities for undergraduates, graduate students, and faculty to prepare them to meet the future needs of this and other communities. A well planned computer system's versatility and ease of access within the university community is conducive to an infectious learning atmosphere utilizing new methods of inquiry, teaching, and research; the sine qua non of any commitment to academic excellence. Since the University of Tennessee at Chattanooga is primarily an undergraduate institution with emphasis upon superior teaching, adequate computer facilities are a necessity, as will be explained below. Modern computer systems employing a simple language provide an effective method for cutting across academic "jargon" and encourage, through a balanced program, the development of collaborative relationships between students, faculty, and administrators as well as with other institutions of higher learning through computer networking.

Scope and Techniques of Study

The University of Chattanooga Foundation commissioned this study to assess the state of academic usage of the digital computer at the University of Tennessee at Chattanooga, to compare this state with that of universities doing a notable job elsewhere, and to propose a rational strategy for the development of the art at the Chattanooga campus. The committee interprets academic computing to include computer usage for student problem solving, for simulation support of laboratory and of classroom activity, for educational management such as computer aided instruction (CAI), self-testing, etc., and for student and faculty research.

Dr. Lloyd D. Davis, Assistant Professor of Education directed the study assisted by Dr. Terrance M. Carney, Associate Professor of Engineering. Dr. Clinton W. Smullen, III, Assistant Professor of Mathematics, and Dr. James A. Ware, Associate Professor of History, assisted in the preparation of this report. An advisory committee consisting of the following faculty members lent their expertise to this study throughout:

Dr. Charles Nelson, Associate Professor of Biology

Dr. Ziad Keilany, Distinguished Guerry Professor of Economics

Dr. Jerrold Packler, Assistant Professor, Business Administration

Dr. David Brodsky, Assistant Professor, Political Science

Dr. Lynn Russell, Associate Professor, Engineering

Drs. Smullen and Ward

This group, broadly representing all scholarly disciplines, provided effective communication channels to other faculty members concerned about the state of computing efforts at the university.

To fulfill its charge the committee collected information on student and

faculty computer attitudes and needs through surveys. A group of prominent consultants were brought to Chattanooga to evaluate the present computing situation, to assess future needs, and to inform the advisory committee, members of the faculty, and administrators of modern practices and trends in academic computing. A series of visits were also undertaken to observe first hand several significant university installations in operation. On the basis of this information the committee extensively debated the various alternative proposals on a cost effectiveness basis.

Present Status of Academic Computing at UTC

The University of Tennessee at Chattanooga leases an IBM 360/30, two small minicomputers for laboratory use are owned by Engineering and Psychology, and one remote terminal for time shared computations is owned by the graduate Engineering program. The 360/30 can also be used as a remote data link to Knoxville's IBM 360/65. The major computing device at Chattanooga, the 360/30, has a small core memory (only 64,000 characters of information) and since it is more commonly used as a business machine than as an academic machine, it has little adaptability for academic instructional or research use. In December 1974, this machine was altered to enable it to transmit programs to Knoxville's 360/65 and to print the output returned from that computer. The 360/65 is a very large and fast machine with a rich variety of software for academic usage. This facility potentially enhances the academic computing environment at Chattanooga and should change to a limited extent academic usage on the Chattanooga campus. Operation of the link between the two computers, however, requires shutting down the 360/30, which carries the administrative computing load for the Chattanooga campus, and thus lessens both machines' effectiveness.

The University of Tennessee at Chattanooga Computer Center currently employs a director, an assistant director, four professional programmers, a number of keypunch operators and student help. The director reports to the Vice Chancellor for Administration, underscoring the importance of administrative computing at the center. A University Computer Advisory Committee, consisting of two students, six faculty members, and four administrators serves as a policy advisory body to the director of the computer center. As currently constituted the computer center's professional staff is primarily committed to the maintenance and improvement of the administrative computing systems.

With the additional load occasioned by the university's move toward a common data base located at Knoxville's UTCC, the Chattanooga staff is very heavily burdened. The computer center has been unable to designate an academic consultant, and programming help is on an ad hoc basis whenever a spare student programmer is available. Moreover, the professional programming staff primarily uses the COBOL and PLI computer languages that are not suitable vehicles for academic work as are the BASIC, APL, and FORTRAN languages. The facilities and personnel at the computer center, although adequate for administrative computing responsibilities, are not even marginally equipped to handle the academic computing the university requires.

Overburdened equipment and staff currently limit instructional and academic applications primarily to teaching students to use the computer as a tool. The Computer Science Department offers a sequence of courses in COBOL, FORTRAN and assembler programming languages leading to a certificate in computer science rather than to a baccalaureate degree, and provides language instruction for several disciplines that require such courses. Additionally, Engineering, Mathematics, and Psychology offer a few specialized courses in computer techniques for their students. These courses were recently altered to use the 360/65 in Knoxville in order to take advantage of the superior error diagnosis offered by the student - oriented computer language compilers available there.

Beyond language instruction the computer is used in a small number of courses for problem solving, and to support class work through simulation in still fewer instances. The Engineering Division has attempted to use the computer as broadly as possible for homework, for laboratory exercises, and for project work. This has involved using both the 360/30 and, for interactive computing, a time sharing terminal connected to Knoxville. The high cost of this latter arrangement has discouraged the extensive development of interactive computing. Moreover, the limitations of the 360/30 have precluded the use of

many large scale analysis programs available at most comparable schools. Business Administration uses a number of games to offer students the opportunity to apply classroom materials in simulated authentic conditions. The games involve such situations as corporate financial management or selection of marketing strategies for a new product, and the computer uses a mathematical model to predict rational outcomes with some uncertainty added. A few statistical analysis programs are used in the business statistics courses and some linear programming packages have been used in the past. Modest academic computer applications are taking place in Psychology, Business Law, Economics, Education, Sociology, and Political Science, but are principally confined to the use of statistical programs for data interpretation. A very large scale community interaction simulation has been used as the basis for an interdisciplinary course in pollution control. It was necessary, however, to run this program at the Provident Insurance Company because of its size and the volume of data required. Finally, an instructional computer application that is not as visible as those cited above is the construction of tests from banks of multiple choice questions. This is done in Business Law, in first year Economics, and in Education courses.

Research activities employing the computer have been carried out by faculty from Biology, Sociology, Physics, and Engineering. This activity often required machine capacity and speed beyond the capabilities of the 360/30 and involved transporting punched cards to Knoxville and having the output mailed back or going to off-campus facilities such as Provident or TVA. Such inconvenience was detrimental to research efforts, but the advent of the remote link to Knoxville could obviate most of this difficulty. There is, however, virtually no professional staff in Chattanooga to assist academic computer users in a substantive way, so that the resources are unavailable to faculty who are not already well prepared in computer methodology.

Subjective evaluations of our current situation were made through student and faculty surveys and through a series of consultants called in to assess our situation and to make recommendations for its improvement. The faculty survey consisted of two instruments, one to determine attitudes and the other directed toward assessing the needs of those using or hoping to use the computer. Of the 138 respondents to the initial attitudinal survey, 49% defined themselves as moderate or extensive past computer users, often citing experiences prior to coming to the University of Tennessee at Chattanooga, and 80% indicated they would like to increase their usage in the future. The responses pertaining to the present state of academic computing revealed that an overwhelming majority of the faculty desired more computer training opportunities, that more than 60% favored increased computer usage in their academic area, and that 39% considered Chattanooga's computer support inadequate (46% had no opinion on this last question, often due to lack of familiarity with the local system). Moreover, by a margin of 39% to 17% the faculty agreed that the existing facility was not conducive to academic usage (44% abstained or had no opinion). While this survey did not isolate specific problems and was taken before the Knoxville link was completed, it confirms the presence of a large community of potential computer users, and of significant dissatisfaction with the existing 360/30 installation.

Two student groups were surveyed, one consisting of upper level Engineering students and a second comprising a homogeneous selection of computer science students. Since the survey was principally interested in determining their attitudes toward the available service, only two pieces of data are pertinent to the current academic computing situation - the present time between job submission and return of the results (turn around time) and an estimate of a desirable turnaround time. Turnaround time is a standard figure of merit for a computer system and currently at Chattanooga averages in the four to six hour

range with occasional wide variations. Sixty-three percent of the two student groups sampled found the present service inadequate and estimated 1.5 hours as a figure for an ideal turnaround time.

To relate Chattanooga's goals to the national computing experience the committee engaged several consultants. Those who visited the campus are:

Joseph Denk, Academic Computer Center Director, UNC-Greensboro

John Hirschbuhl, Director of CAI at the University of Akron

Theodore Sjoerdsma, Manager of Academic Computing at the University of Iowa

Arthur Luehrmann, Associate Director of Kiewit Computation Center, Dartmouth College

James Johnson, Director of CONDUIT, the NSF sponsored software organization

John Merrill, Director of the Center for Education Design at Florida State University

Marvin Hoffman, Assistant Professor of Political Science at Appalachian State University

Individuals not supported by UTC who also aided the study were:

Leon Elsworth, IBM-New York on Computer Modeling

Harvey Long, IBM-Washington on CAI

In addition, valuable meetings were held with:

Gordon Sherman, UT Computing Center Director

Ronald Boling, Director of UT Computer Services Planning

Their reports are appended in the accompanying reference volume, but they show agreement in several important respects:

1. The faculty has the potential to develop an active academic computing effort.
2. The current state of Chattanooga's academic computing is below the national norm for the following reasons:
   a. The IBM 360/30 is inadequate for academic computing because of its limited size, speed, and computer language support, although the IBM 360/65 improves this situation.

b. The enclosed, centralized facility limits the development of academic computing because of its relative inaccessibility.

c. The organization of the computer center's staff, with no designated advocate for academic computing and a heavy administrative computing load, has restricted academic usage and will continue to do so unless some alternative arrangements are developed.

The perceptions of the students, faculty, and consultants uniformly condemn the adequacy of the current academic computing facilities at Chattanooga. The students' and most of the consultants' evaluations were made after the Knoxville link was installed, indicating that this improvement in its present form is not sufficient to remedy the problem. The consultants' stressed the fragility of academic computing, emphasizing that it requires a great deal of commitment from a faculty member who is already heavily burdened with teaching and committee obligations. Efforts must be made to improve the computer's accessibility if academic computing is to prosper.

Consideration must be given to the costs of maintaining the academic computing status quo at Chattanooga. Realistically, modern computing techniques do not promise to reduce instructional costs substantially in the near future. They can raise instructional quality and increase the retention of students, but since they have been primarily used as supplements to traditional instructional methods they consequently add to costs. In a period of stringent financial limitations, the option of foregoing these expenses must be considered regardless of national educational trends.

Dr. Theodore Sjoerdsma, a consultant from the University of Iowa, however, put the consequences of a prolonged status quo succinctly,

"Academic institutions (like UTC) without adequate academic computing which reaches into instruction in every discipline,

> will find themselves within 10 years in the unenviable position of providing an inadequate education. The recruiting of quality faculty will be more difficult, but probably more dramatically, students accustomed to computer aided and individualized instruction in high school will opt for an institution which provides such facilities."

Academic accreditation is also a major concern of the total university community and academic computing is becoming increasingly important to the accrediting agencies. In particular, disciplines such as Engineering and Business Administration find the quality of computing facilities is important to accreditation review committees.

With fifteen precent of the total work force daily using the computer and estimates of this rising to forty percent in ten years, knowledge of the capabilities of the computer, awareness of its limitations, and the demystification of its supposed powers are essential for a well informed public. Certainly this is imperative in higher education; the status quo will only perpetuate indifference toward the computer and elitist attitudes among computer professionals.

The computer has enriched areas currently where it is properly employed, will extend learning capability in those areas where it is being initiated, and will encourage new instructional awareness in areas not traditionally associated with computing. By preserving the status quo, UTC will maintain an already untenable educational position and insure an increased technological instructional lag now estimated to be ten years. With relatively modest support for academic computing, UTC can achieve a level of computing consistent with the national norm, above that found in similar institutions in the Southeast, and build a base from which increased impact on the curricular process can be made. For the maintenance of a quality undergraduate education, therefore, the availability of low cost solutions to Chattanooga's computing problems

led the committee to reject the status quo as a viable alternative for the University of Tennessee at Chattanooga.

Current Trends in Academic Computing

Current trends in academic computing highlight the machine's indispensibility and versatility for higher education. Its ability to perform large-scale calculations, data manipulation, and information retrieval at increased speeds has vastly expanded while the machine itself has been refined, reduced in size and price, and augmented by sophisticated auxiliary features that allow users to communicate directly with the computer in a simple language, on a one-to-one basis, with exceptionally rapid response time.

For early computers, a user prepared a set of instructions (a program) on punched cards in a strictly prearranged format. The deck of cards was then arranged in order and "job control cards" were inserted to inform the computer of the details of his request and the cards left at the computer center to be entered into the machine. All such jobs were relegated to a queue and run through the machine only after earlier jobs and those with a higher priority were executed. Results were obtained in a time range from a few minutes to several days. This is called "batch processing," or "batch entry."

Batch entry computing has traditionally been the mainstay of university computer centers because general purpose computers perform this function well. Much academic computing, moreover, has involved entering massive amounts of data into the machine and calling on the computer to sort and calculate the facts into meaningful sequences. And there are two things batch computing does extremely well: it disposes of problems requiring large amounts of computer memory with ease and it performs its tasks within a reasonable time. Over the last few years academicians have capitalized upon these factors and have developed standardized program "packages" such as the Statistical Package for the Social Sciences and the Statistical Analysis System to enable individuals without previous computer experience to manipulate their data effectively. To further

standardize the process, data files are now available on such diverse topics as American Studies, U.S. Energy, the Supreme Court in American Politics, Congressional Roll Call votes, popular political views, electoral voting behavior, census tabulations, sequences on balance of payments vs. price indices, and on employment, biological taxonomic information, and a wide variety of medical data. Entered into the computer in a standardized format and available through routine procedures, these packages have helped to revolutionize research techniques in the last decade.

Batch entry computing has had only minimal instructional applications apart from teaching programming. Perhaps the most popular computer usage has been in test construction for evaluation purposes and prescriptive testing. Using prescriptive testing, students may test their knowledge of a subject without fear of an adverse grade, essentially in a practice mode. Computer test pools are of two types, item pools and skeletal structures. In the first, thousands of test items are entered into the computer's memory, indexed by subject area, and catalogued by difficulty. These items are carefully tested for significance before being placed in the test pool, and reviewed periodically to ensure that they remain significant. The pool is large enough to extract many tests without significant overlap, has its own answer key, and is graded by the computer which also supplies the instructor with appropriate statistics on student performance and item analysis. The skeletal test has a basic structure such as X + Y = Z and supplies two of the variables asking the student to calculate the remaining one. Such tests have random variable generators that make the variational possibilities almost limitless. Computer testing allows students to browse sample tests, retake different examinations over the same material until their proficiency reaches a predetermined standard, and thus offers individualized study and test preparations. This approach has particular importance in competency based instructional programs.

Academic computing continues to depend heavily upon batch entry to process

large information collections, but the process has a number of serious drawbacks. It is relatively inflexible in that data must be submitted in a preset order, entered upon time consuming and expensive cards or tape, and run in a predetermined sequence. A knowledge of complex programming, although no longer a necessity, is still desirable for optimal results and programming knowledge depends upon an acquaintance with one or more computer "languages," a time consuming and often an expensive requirement. For many, the time limitations are vexing; for a wait of several days to retrieve meaningless results means only that one has to run through the entire procedure again. Finally, the computer's reputation for dehumanization is enhanced by this process, for even those knowledgeable in programming must submit their information and program to an outside party who is privy to the arcane machinations of the instrument that may nullify years of research. The fact that the computer is divorced from its user, often hidden in the basement of the oldest building on campus, only heightens psychological antagonisms in many users and frightens away potential beneficiaries.

Many of these objections have been mitigated in the last few years by the development and spread of "interactive" computing. In this process each user has direct access to the computer through a terminal with a typewriter keyboard and in some cases a graphic display device. Graphic devices, such as cathode ray tubes, have the capability to display answers and draw pictures. The computer can also generate signals which are interpreted by an electromechanical device called a "plotter" and displayed. These displays may be used in the classroom, or copied to produce transparencies, moving pictures, or several other forms of visual aids. With suitable programming the computer can produce these displays quickly and with a minimum of work on the part of the user. Such equipment, using a very simple computer language such as BASIC, can "talk" directly with the user, answer his queries, and even prompt the uninitiated with information on how to properly employ the machine. The arrange-

ment works on the basis of "time-sharing" where a number of simultaneous users are allotted a "slice" of the computer's time, and, on a round-robin basis, each user receives his time slice in turn; the interval from completion of one line of input until the computer signals it is ready for another is usually less than five seconds.

This rapid turnaround time and the one-to-one direct relationship between the user and the computer helps alleviate machine alienation. Moreover, the flexibility inherent in such an arrangement opens new educational vistas for use of the machine as a teaching aid. Major universities such as Akron, Illinois and Florida State currently offer students in a variety of courses a procedure called "computer aided instruction" (CAI). This procedure requires special equipment for interactive computing, but the student need not know anything about either computing or programming to benefit from the process. The CAI programs range from simple drill and practice exercises to tutorial dialogues between the student and the computer. In the first instance the student routinely practices assignments, almost endlessly if necessary, with the computer thereby freeing the instructor for other work and permitting the student to advance at his own pace. These sessions are valuable for disciplines that require a body of basic knowledge, such as spelling, mathematics, chemistry, foreign languages, grammar, statistics, tests and measurements, and many others. Unlike instructors, the computer is always patient and non-threatening. For the more advanced courses, interactive computing makes possible simulations, or models of real events or phenomena, that allow students to manipulate variables and to predict their effects on the overall model. Simulations of the Millikan oil drop experiement, particle acceleration, fruit fly reproduction, population expansion, and economic, marketing, finance, and administrative models are widely available. Sophisticated tutorial programs are also available for interactive computing. Students using such equipment can investigate binomial

expansion, statistical measures such as mean and variance, strategems for chemistry laboratories, correlates from social data, and many more topics, subject only to the limitations of the students' and instructors' imagination and abilities.

A variant of CAI instruction, known as computer managed instruction (CMI), may be used for paraprofessional instructional purposes. In this case the computer is used for classroom record keeping, for information on student progress, for suggested supplemental instructional sources, and for mastery testing. CMI thereby frees the instructor to concentrate on the process of teaching with increased individualism, while relegating the necessary but time consuming classroom management functions to the computer.

Although interactive time-sharing computing lends itself to many more instructional exercises, its most important asset is the integration of the human factor with the machine. In this environment the student can usually complete his assignment in one sitting rerunning to correct errors that in the batch system would cause a delay of days, thereby disrupting the student's thought process and lessening the immediacy of the assignment. Time-sharing terminals can be provided in scattered locations so that most students can reach them with a minimum of effort, and the simplicity of the language and the terminals allows the student to concentrate on the substance of the exercise rather than on the computing itslef. Moreover, the rapid turnaround time invites the student to experiment beyond his assigned exercises. Faced with real situations and real data the student can merge his academic work with post-collegiate reality. The student will be exposed to the computer for the remainder of his life and must be prepared to view computers in the context of his own field. Basic computer literacy is likely to be in great demand in the future and the cost to today's student of acquiring computer knowledge is lower than it will be at any future time.

Derivation of Goals

Student and faculty surveys and visiting consultants were used to determine the short and long term goals necessary to provide Chattanooga with adequate academic computing facilities. A solid starting point was the agreement by 80% of the faculty respondents with the following statements in the initial survey:

(a) Computers are necessary for instruction in the natural sciences, engineering and mathematics.

(b) Students in the behavioral sciences desirably require access to computers for problem solving.

(c) Students in business administration must have knowledge of and practice in the uses of computers in business applications.

(d) Students from the humanities should have awareness of the influence computers exert on our society.

A follow-up poll was conducted to determine the computer resources desired and required by those faculty members currently either moderate or extensive users. Forty-two faculty members declared that access to adequate computer facilities was important to their instructional and research efforts. Of particular significance for research, they agreed, is access through batch facilities (by means of a card reader and line printer) to services such as those provided by the UTCC in Knoxville. The majority of the respondents ranked undergraduate instruction as their primary use for the computer, followed by professional research. Almost three fifths of the faculty respondents stipulated that interactive computing was necessary for the instructional process at UTC.

Eighty percent of the students with majors in engineering, mathematics, the sciences, psychology, and business administration surveyed replied that computing was of either medium or heavy importance to their intended careers.

Improvements in UTC's interactive and remote batch facilities were deemed especially necessary by the students. Among those students with time-sharing experience (less than half of the sample), forty-two percent of those who requested improved facilities asked for increased time-sharing services; the majority of these students agreed time-sharing allowed much easier program development than a batch system.

The consultants, previously listed and identified on page 9, met with interested faculty, students, and administrators to determine, based on their experience, Chattanooga's academic computing needs, to discuss the national experience, to suggest available educational computing materials, and to advise the Academic Use Advisory Committee on a necessary and appropriate level of computing. These consultants collectively recommended that the following capabilities be established at UTC:

(1) Time sharing facilities using a simple interactive language (BASIC was suggested), supporting 25-32 keyboard terminals, either cathode ray tube or typewriter.

(2) Access to a large, fast central computer such as the 360/65 at Knoxville by means of remote batch entry (card input and line printer output).

(3) CAI and CMI support languages for faculty authorship and student use, in an author language with broad national use.

(4) Five terminals dedicated to CAI/CMI use.

(5) Graphics capabilities, including plotters and software support.

(6) Remote job entry to the 360/65 from any local terminal with a valid account at UTCC.

Other recommendations included:

(1) Faculty training through workshops and seminars.

(2) Released time and other incentives for faculty development,

including an instructional awards program to support innovative applications of instructional technology.

(3) Membership or other participation in CONDUIT, an educational software organization with national distribution.

(4) An organizational change to remove academic computing from the control of administrative computing.

(5) Appointment of an academic computing coordinator to serve as a consultant to the faculty, to organize workshops and training seminars, and to be a focal point for instructional usage of the computer.

(6) Establishment of a UT System level organization for academic computing to assist all campuses with transporting, installing and developing educational software.

A partial list of available software for educational use appears in Volume III. It should be noted that this software touches fifteen separate departments at UTC, whose combined student majors account for three-fifths of all student majors.

For first-hand information on the various educational uses of the computer, a number of campuses with significant ongoing activity were visited. UT-Chattanooga faculty observed computer installations at Carnegie Mellon, the California State University System office, California State at Los Angeles and at San Diego, Brigham Young, Ohio State, and the Universities of Akron, Iowa, Illinois, and Washington State. Moreover, faculty members participating in this study provided experience previously gained at Dartmouth College, Rice University, Massachusetts Institute of Technology, the Universities of Tennessee at Knoxville and North Carolina at Charlotte, Purdue, and Triangle Universities Computation Center (TUCC).

TUCC, the California State system, Carnegie Mellon, Dartmouth and Iowa

are paramount models of effective time-sharing services; San Diego State has the foremost facilities for construction and use of test banks; Ohio State, Akron, BYU and Illinois all possess excellent CAI efforts. Most of these institutions have excellent batch services, information retrieval services,and a large selection of software packages. The UTC study group had the opportunity to verify the appropriateness of many of the consultants' opinions, and to gauge the state of the educational computing art at the national level. This enriched awareness of the available possibilities for UTC convinced the committee of the necessity for time-sharing services, CAI, and remote batch entry to a major computing system. These facilities, supported by a vigorous faculty self improvement effort through the use of incentives, workshops, released time, and institutional commitment, must be present to provide a quality contemporary educational experience for students at UT-Chattanooga.

To provide quantitative information for this study, a computer model originally developed for the California State University system was adapted for the Chattanooga campus. This model was used to project the anticipated academic computing workload for each of California's campuses and the hardware necessary to deal with this load. It employs information such as the full-time student equivalents of each institution, the number of majors by department, and faculty perceptions of the amounts of computing desirable for students by discipline. Using current information from UTC, this model, adjusted for current trends in academic computing, projects a need for twenty-three time-sharing terminals and one batch station for 1975. Eighteen of these twenty-three terminals are primarily for time-sharing on a larger central computer. The batch terminal would consist of a card reader and line printer connected to a computer such as the 360/65 at UTK for problems requiring large amounts of memory or those needing very fast processors. The importance of the California

State model is that it gives a quantifiable minimum for acceptable academic computing at UTC, based on the local mix of student majors and the needs for computing by discipline.

The longer term goals for academic computing at UTC are to provide opportunities for faculty and for students to experience computing as an integral part of the educational process. Computers should be available to all faculty and students, with the resources to support their activities. The experience at other universities has been that early in the development of a computer resource, the computer supports faculty research and instructional efforts in the sciences, mathematics, and engineering; more computer usage in the arts and the humanities can be expected as students and faculty gain familiarity with and more faculty are encouraged to make use of this tool. At Dartmouth, eighty-five to ninety percent of the undergraduates and virtually all of the graduate students utilize the computer in a given semester; for this level of usage, approximately one terminal is required for every twenty students.

Evaluation of Options

Several options exist for reaching the academic computing goals set forth in this study. They merit a comparison of costs, effectiveness, staffing and training needs, and their short and long term implications. The machine problems and the staffing/training questions are relatively independent and will be considered below separately.

The hardware requirements are thirty-two interactive terminals dispersed in clusters around the campus and supported by a reliable and responsive general computer. The computer should furnish a flexible interactive language (preferably an extended BASIC) and a computer assisted instruction authoring language such as Coursewriter III. Moreover, remote entry of batch programs to a facility with an array of capable software should be provided. The hardware requirements can be separated into terminal needs and computer choices since the function and cost of the terminals are relatively independent of the computer.

Terminals:

Three major types of terminals are available, each possessing certain unique capabilities.

1. The typewriter terminal provides the advantages of low initial cost, about $900 to $1500, and a printed output, but possesses the disadvantages of low reliability, high noise, slow output speed, and continuing paper costs. Recently developed typewriter terminals have improved reliability, speed, and quietness, but they are more expensive, $1200 to $2000, and have higher operational costs due to the need for a special paper.
2. The cathode ray tube (CRT) terminal is much faster, has high reliability, and requires no paper, but has a higher initial cost, $1100 to $3000. No permanent record can be made from the terminal unless a hard copy attachment is purchased.

3. The graphic terminal is a CRT that is capable of displaying lines and curves as well as letters and numerals. It has all the advantages of an ordinary CRT with the added pedagogical benefit of direct display of plots and physical variations. The output may be preserved by a hard copy unit. The initial cost of such units is high, $3000 to $12,000, because they must be able to store information internally and support a larger display area.

For Chattanooga's requirements a mixture of the three types, two graphic terminals, 15 typewriters, and 15 CRTs is most desirable. This combination requires an initial capital outlay of $39,000 and an annual maintenance charge of $8,000.

Computers

Three distinct options are available to provide the necessary computer support: utilize the 360/65 at the Knoxville computer center which has interactive capability, upgrade our local computer to provide interactive and batch capability, or purchase a "minicomputer" with large-scale interactive computing support capacity and a simultaneous capability to send batch jobs to a larger remote computer. For direct cost comparisons between these options, some of which involve lease and some purchase, equivalent yearly costs are calculated by amortizing capital investments over a five year period.

1. Networking to Knoxville involves total dependence upon the Knoxville 360/65 and the communication lines to that machine. This computer has several interactive languages available, but its BASIC language is poorly developed. A second disadvantage is that the machine must be used in competition with the Knoxville students and it is already heavily loaded. The major disadvantage, however, is the cost which includes telephone line charges, a direct cost of $.50 each hour the terminal is linked to the 360/65, indirect costs of $4.50 per hour, and charges for keeping the

program stored in the Knoxville's computer. The estimate here of 30,000 hours of usage per year is probably conservative based upon the predictions of the California State model, and the overall costs clearly disqualify this approach.

Network to UTCC (30,000 hrs/yr. usage).

Direct connection charge (.50/hr)	$ 15,000
Telephone line and multiplexer	18,600
Disc storage charges (1000 student/fac.)	3,650
Total direct charges	37,250
Indirect charge (4.50/hr.)	135,000
Direct plus indirect charges	$172,250

2. (a) The purchase of a medium-size local computer with capability to do both interactive and batch computing is one method of upgrading the local facilities. Digital Equipment Corporation's System 10 is the most economical alternative in this class. The capital cost of such a machine is about $400,000, with $18,000 in annual maintenance charges. The computer provides superb interactive capabilities but not the rich data base selection and software available on Knoxville's 360/65. Once again, high costs make this an unfavorable alternative.

Purchase DEC-10

Capital amortization	$80,000
Maintenance	18,000
Total charge	$98,000

(b) A second possibility is to modify the existing IBM 360/30 to enable it to support interactive computing. This alternative requires the addition of new hardware and software. The major shortcomings of this option are the poorly developed interactive language system, the machine's inherent low speed, and high costs. Even discounting costs, this machine would only marginally fulfill the academic computing needs.

Upgrade IBM 360/30	
3704 coupler (1700/mo.)	$20,400
Additional memory	16,800
Additional software (ITF+CWF)	4,800
	$42,000

3. Two minicomputer manufacturers have introduced new machines capable of simultaneous interactive computing and transmission of batch jobs to a remote computer. These machines have hardware designed primarily for interactive usage, support 32 terminals, and take advantage of new technology to reduce costs and improve performance. Each of these computers supports an excellent BASIC language capability and a satisfactory author language for CAI. Intense market competition has driven their prices down making the cost of this option clearly the most favorable. Moreover, it seems to present no major disadvantages of consequence. The system is easily expandable to meet short and long term needs merely by attaching additional minicomputers and terminals, with no present limitations on growth capability. Most significantly, this alternative promises to improve the university's total computer performance.

Minicomputer plus networking	
Capital amortization	$20,200
Maintenance	7,100
	$27,300

Staff support and training cannot be neatly resolved by choosing between several alternatives but rather involves the selection of an acceptable level between minimal support and a complete staff organization. Moreover most staff expenses represent a continuing university commitment rather than a one time investment. The following costs will be estimated as first costs or annual (continuing) costs and subsequent staffing will be increased with each level's costs added to those preceding.

Minimal Training Level

The lowest cost approach to support academic computing would be to sponsor a series of workshops for the various disciplines within the university. They should commence with a BASIC language course presented by Chattanooga faculty members followed by workshops in general areas such as CAI and in more specific disciplines such as the Behavioral Sciences. A minimum of ten workshops would be required with approximately six run by outside consultants who would conduct two-day intensive seminars costing about $500 each. To encourage maximum faculty participation quality materials acquired by the university should be used. Assuming that local faculty will contribute their time, the total cost of the workshops would be $5,000.

Released Time or Overload Pay and Travel

A second level of support would be to offer overload pay or released time to faculty members willing to make computer curricular applications. A travel allowance would permit faculty members first hand contact with similar applications at other institutions or opportunities to attend professional conferences to learn from people with related experiences. If this plan supported 20 faculty on overload for a period of two years, with a travel fund of $500 per grant, the total annual cost would be $12,500. Even this level, however, does not satisfy the consultants' suggested need for staffing.

First Level With Coordinator

One of the consultants' major recommendations is that a person be designated academic computing coordinator, preferably responsible to the Vice Chancellor for Academic Affairs. An inexpensive solution would be to provide a half-time appointment for a faculty member and to fund student programming assistance. This coordinator would furnish consulting help and programming support for a modest number of faculty interested in developing computer based curricular materials or in applying such materials developed elsewhere. To

be effective, this support should continue for two years so that alternative staffing can be finalized. This proposal would cost $8,000 per year for the released time and $4,000 annually for student help for a total of $12,000. This method does identify a responsible advocate for academic computing, but does not strictly satisfy the level of help recommended by the consultants. In order to reach that level it is necessary to consider a professional staff. This support level will not provide sufficient encouragement for faculty who wish to incorporate the computer into their coursework. In an institution where faculty loads are quite heavy, there remains the risk that relatively few faculty will be motivated to exert a significant effort in this direction, particularly where texts and programs may not be readily available. Several consultants recommended offering tangible inducements to attract faculty to the concept of computer aided instruction.

Professional Staff

A total commitment to the rapid development of academic computing would involve employing a full-time Academic Computing Coordinator. This person would ideally report to the Vice Chancellor for Academic Affairs and would coordinate his operations with the Director of the Computer Center, or as an alternative would serve as an Assistant Director for Academic Computing, reporting to the Director of the Computer Center. The position would require a permanent commitment on the part of the university, but the half time coordinator would no longer be necessary, although the student help should remain. In addition, secretarial support should be provided for this position. An annual budget for this level would be $24,500 per year with a savings of $8,000 annually for the first two years on an incremental basis. Total annual cost at this level would be $28,500 including student help. An additional $17,500 (I,II,III) would be required in the first year and $12,500 (II,III) in the second.

Affiliation with CONDUIT

Each level discussed above would improve the probability of rapidly strengthening academic computing at the University of Tennessee at Chattanooga, with the final level maximizing Chattanooga's opportunities to excel locally and to make a positive contribution to the national community of academic users. Selection of the appropriate level is strictly a problem of budgetary constraints.

Consideration of forming an association with CONDUIT should be undertaken for development of curricular materials using the computer. CONDUIT is the richest source of reliable computer based course material in the country, and their major current effort is to expand their resources, carefully testing proposed new materials, ensuring that such work will perform as advertised when used in almost any campus computer. UTC should affiliate with this organization. The cost involved should be nominal since CONDUIT is underwritten by the National Science Foundation.

System Level Support

The consultants' also recommended the establishment of an academic computing support group at the University of Tennessee System level. The basis of this recommendation is that such a group would serve a large enough body of users to make possible real economies. This concept was pioneered by the Triangle Universities Computer Center in North Carolina, and exists in modified form in the consortium of universities that forms CONDUIT.

An academic computing support group would consist of a small number of experts who would be available as consultants to faculty on all the campuses for computer curricular applications. Moreover, these experts would keep abreast of national developments and their use for the local level. This recommendation entails no direct action on the part of the University of Tennessee at Chattanooga other than approval and suggestion to the system level.

Users Organization

The ad hoc Academic Use Computer Advisory Committee should be permanently constituted so as to give academic computer users a vehicle for both information dissemination as well as input to the UT-C computer advisory committee. It is recommended that faculty serving on the UT-C computer advisory committee be members of the academic computer users committee and that enough other members be appointed to the latter committee to bring its membership to ten.

RECOMMENDATIONS

As a result of this study, the Academic Use Advisory Committee earnestly recommends the establishment of an academic computing facility at UTC and makes the following specific suggestions.

To start, 32 terminals and a minicomputer capable of supporting them in a time-shared interactive mode should be procured. This computer should have extended BASIC language capability, a good author language for construction of Computer Assisted Instructional material, and be capable of acting simultaneously as a remote link to a large computer (i.e. UTCC's IBM 360/65). See Appendix for the functional requirements of a minicomputer system. In addition, faculty workshops for the first year should be funded. The following capital costs would be involved:

minicomputer	$101,000
terminals	39,000
workshops	5,000
	$145,000

Recurring expenses for maintenance:

minicomputer	$ 7,000
terminals	8,000
	$15,000

The total request for capitalization plus one year's operation would be $160,000. In the opinion of the consultants, the Academic Use Advisory Committee and the UTC Computer Center Director, a card reader and line printer for the remote link to Knoxville would be a valuable enhancement to this system. This would serve academic computing at UTC by providing a constant tie to the UTCC rather than the current intermittent connection, and should reduce batch turnaround time to the desired 1 - 2 hour range for most jobs.

The capital cost of this option is:

card reader	$ 6,000
line printer	8,000
	$14,000

Additional annual maintenance charges would be $1,500. For the first year, this option would add $15,500 for a total package price of $175,500.

A prior section dealt with the various possibilities for augmentation of the academic computing effort by staffing. To avoid repetition, a table of additional costs by level is presented here.

OPTION	INCREMENTAL COST	TOTAL COST
1. Overload, released time, travel	$15,000[1]	$190,500
2. Part-time coordinator	12,000[1]	202,500
3. Professional staff	16,500[2]	219,000

1/Recommended for second year also.

2/Increase to $24,500 per year long term commitment

The initial 32 terminal block will guarantee adequate access to the computer and will serve the needs of the campus for at least two to three years, by which time it is likely that system improvements will allow the minicomputer to serve larger numbers of terminals after a relatively low cost upgrade of the hardware. If this has not happened, it will be necessary to expand through the purchase of a second minicomputer with terminals, but some of the initial costs can be avoided. It is anticipated that the cost of terminals will continue to decrease. Further expansion of capacity in the future would generally follow the same pattern of upgrading existing machines' capability and the purchase of additional machines, with the eventual possibility of linking two or more minicomputers together in a network for improved performance.

Along with machine and staffing recommendations the committee suggests

that UTC affiliate with the CONDUIT project. As noted previously, this will provide access to excellent materials; the only likely costs are a limited amount of supplies to transfer materials (magnetic tapes, for instance) and travel funds to attend meetings. This expense appears to be well justified.

If it is possible to capitalize this academic facility as suggested, the remaining annual operating cost is very small, particularly since approximately 100,000 hours of terminal operating time is potentially available each year. In light of this low upkeep (as little as $0.15/hr.), the advisory committee recommends that this facility be treated as a free resource to students and faculty rather than running a billing system to the user. Records could be kept on computer use by course number in order to reflect instructional costs to the State, but the return for individual billing hardly seems worth the added cost. In particular, the Dartmouth experience indicates that roughly 90% of the users will accrue very little time on an individual basis, together using only 40% - 50% of the total computing time. To encourage very broad participation in academic computing, it is important to remove every hurdle, and budgeting at the Departmental and individual faculty level for this activity appears to be one expendable burden.

Specification and Procurement

Should the University wish to establish an academic computing facility, it is important that the final machine configuration, terminal placement, and similar questions be resolved in a way that meets faculty and student needs. The Academic Use Advisory Committee is cognizant of these problems, and moreover represents a cross section of the potential users. It is recommended that Professors Davis, Carney and Smullen be appointed to the specification task, (functional specifications specified in Appendix) together with representatives from the UTC Computer Center, and the Systems Group at UTCC. Dr. William Blass, a user of a minicomputer in an academic environment at UTK, and Dr.

Joseph Denk, Director of Academic Computing at UNC-Greensboro (who has just gone through just such a specification) would be valuable consultants.

Users Organization

A Computer Advisory Committee, made up of representatives from the faculty and administration, currently exists at UTC. This group is principally advisory for Computer Center policy development. For the community of academic users, however, most of these policy considerations are moot. Accordingly, it is recommended that a permanent academic users group be established, consisting of the student and academic representatives on the Computer Advisory Committee plus additional active academic computing users to ensure full and broad representation. This group would make policy recommendations on the operation of the academic computing facility only.

Faculty Incentives

A final recommendation is for the institutionalization of faculty incentives for development of academic computing materials and of applications of educational technology. The committee recommends two strategies to achieve this. First is that the Administration recognize development of curricular material as a positive contribution in promotion and tenure decisions, similar to research and publication. This suggestion is consistent with the primary role of UTC as an undergraduate teaching institution. The second is for the establishment of Instructional Development Grants similar to the current Research Grants funded by the University of Chattanooga Foundation. These grants should be awarded for innovative curricular development such as individually paced courses, and the use of the computer for instructional purposes. They would be most effective is used for direct support of a faculty member, to replace a term of summer teaching. Moreover, the funds could be used to support travel to observe the use of analagous material elsewhere.

The committee has found this study to be most instructive. Many UTC

faculty are excited by the prospect of moving in the direction of strong academic computing, and it is with high hopes for the establishment of a computing effort that will be notable in the Southeast that the committee submits this report.

APPENDIX

THE UNIVERSITY OF TENNESSEE AT CHATTANOOGA

CHATTANOOGA, TENNESSEE 37401

TO: Selected Computer Systems Vendors

FROM: Lloyd D. Davis, Director
UC Foundation Computer Study

DATE: April 2, 1975

The University of Tennessee at Chattanooga submits the attached specifications for a computer system to be delivered before August 1, 1975.

The selection criteria (Section II) are written, where possible, in terms of functional capability. The intent is to allow the criteria to be met by different combinations of hardware and software. However, it is possible that this sort of generality has not been used to full advantage. In such cases, the vendor should feel free to propose a better total system with different hardware and software capabilities. Such a deviation will require ample justification. Also, if a specific hardware requirement calls for a piece of hardware requiring a major new development in your line, please request authorization to propose your lesser piece. Furthermore, all of the information should be presented so that the total effect (including cost) of adding additional capabilities, such as more executable memory or more disk units can be easily ascertained.

The proposal should be keyed to the selection criteria outline (see item III A). All information pertinent to a particular criterion should be given in its place in the proposal at the expense of some (but not excessive) redundancy if necessary. The computer system proposed should be listed in detail with costs as required by item II D 1 and 2, but should also be displayed as a configuration diagram. The proposal should be complete and require no verbal explanations.

UT-Chattanooga is dedicated to instruction, research, and public service. It currently has a remote batch connection into the IBM 360/65 at UTCC (University of Tennessee Computer Center) at UTK. UTC intends to continue its use of the services provided by the IBM 360/65 and will entertain no proposal that suggests an alternative strategy. The time sharing system proposed is to add local interactive and CAI power with no reduction of the batch capacity from UTK. It is important to structure the proposed architecture such that the batch capacity from UTK can be upgraded with a line of products compatible with the proposed system. No proposal will be considered that suggests a stand alone or degraded RJE capacity.

Questions regarding interpretation of some requirements are inevitable. Each one should be submitted to Lloyd Davis (615) 755-4468 in written form (read over the telephone if desired). It will be answered as promptly as possible and a written answer (along with the question) will be sent to each participating vendor.

If you choose to respond, ten copies of your proposal must be delivered to UTC no later than June 15, 1975.

UNIVERSITY OF TENNESSEE AT CHATTANOOGA

Specifications for a Time-Sharing Computer System
for the Academic Computer Center

I. GENERAL INFORMATION

The University of Tennessee at Chattanooga (UTC) has a single computer center with its own facilities and is charged with providing both academic and administrative services. The current system is batch and it also acts as a remote link to UTCC's 360/65 at UTK. Two interactive terminals to UTCC exist for use primarily in a graduate engineering program.

Through this environment, UTC runs a maximum of 2000 batch jobs per month at UTCC. In the next three years, this volume can be predicted to reach 3000 jobs per month. The time-sharing computer system as specified here is not predicted to reduce this potential capacity but must be constructed so as to enhance RJE activity. In fact, it is predicted that the system will increase rather than decrease the computing volume at UTCC.

Despite the two keyboard terminals to UTC, the interactive computing activity is less than 5 percent of current usage. The high cost of remote interactive services has made this mode of computing prohibitive for general usage. Local time-sharing, as specified in this request for proposals, is seen as the only cost-effective solution to allow the development of this mode of computing for the instructional process.

The system desired must be capable of supplying Computer-Assisted-Instruction, CAI, as is required in higher education and at a cost that would deliver time-sharing as well as CAI to a large number of students at a cost of less than $2 a contact hour. Since this system is not specified to replace any of the instructional computing done through UTCC but rather to augment this

activity, it will be necessary to have the system compatible with the UTCC facilities. It is not desirable to have a totally separate time-sharing system that could not interface with files nor share software at UTCC. The CAI development for higher education at UTC cannot be restricted to a minicomputer. It is essential that the manufacturer be able to deliver a standard 32 user BASIC system capable of supporting the device types specified below on or before August 1, 1975. Further, delivery of software components allowing the interface function with the IBM equipment must be made on or before January 1, 1976.

2. General Description of the System Required

UTC wishes to provide a multi-user interactive BASIC language system capable of use through standard keyboard terminal devices. The BASIC interactive language service must be supplied from an existing, fully debugged, general purpose, proven manufacturer provided hardware and software combination system. An immediate potential capacity of supporting 32 simultaneously connected and active users on terminals not exceeding 300 baud is necessary. All users must have, in addition to capacity for computation in BASIC, access to significant amounts of disk storage capacity for storing programs and data files developed by this program or entered through terminals. The proposed system must contain integral accounting mechanisms which record systems usage including, at least, connect time as measured from sign-on to sign-off, and storage of these mechanisms and files on a systems-accessible, protected, disk file. General protection mechanisms must be offered which prevent the malicious destruction of files by unauthorized users. Access control through passwords or sign-on codes must be included.

Because of the need to interface this system with the UTCC IBM 360 Model 65, it is desired to interconnect the hardware providing the BASIC service with the UTCC system. This connection must provide a functional interface which will allow the transfer of files of data (for input to batch jobs) from the BASIC system to the IBM system and allow their return. Files returning from the IBM system may be placed either on the disks of the proposed system or routed to a printer connected to this system. Further, the system must support two or more medium speed card reader-printer combinations so that job entry and output may be either through keyboard or card reader/printer. Access

on a record by record (or line by line) basis by the terminals connected via the BASIC processor to the IBM system must be provided so as to allow call-up and execution of interactive jobs on the IBM system.

The system proposed, therefore, must supply a remote message concentrator function. With the IBM system residing 110 miles from the proposed location of the BASIC system, it is necessary to employ binary synchronous communications conventions standard to IBM equipment over a leased line. All of the current HASP remote job entry activities for job entry and return as well as access through TCAM (an anticipated TSO general purpose, IBM provided, interactive facility) must be supplied in this concentrator function. (If TSO is not provided nor anticipated by UTCC, then an alternative solution to this portion that would be acceptable is the ability to access the UT time-sharing system (UTTSS) at UTCC on UTK's 360/65.) The system would have to supply the local time-sharing BASIC as an addition to and not a replacement of these functions.

Applications software dedicated to higher education must be available with the proposed system. Mere references to software on other systems are totally unacceptable. This software must include at least one proven CAI author language, a statistical package involving regression and multivariate analysis, a graphics package, a mathematics package, and a large general purpose utility library. All software must be debugged and proven reliable at demonstration sites. A variety of compilers for several languages will not be important considering the availability of languages through the concentrator function specified.

It is necessary that the overall system run completely unattended (other than start-up) and contain integral utilities necessary for periodic dumping, restoring or selection (using magnetic tape) of data

from the system's disk files. It is further expected that all maintenance service be provided by the manufacturer under the terms of a monthly contract. The maintenance personnel must be based within 150 miles of UTC and available for same day service during the 40 hour working week as well as for on-call service at night and on weekends.

The manufacturer should be able to deliver the system on or before August 1, 1975. The concentrator function must be tested at a mutually acceptable place before submission. The due date for the concentrator function is January 1, 1976.

No proposal should be submitted that requires the simultaneous operation of current RJE and TSO facilities with the new system while the concentrator function is debugged. The installed system must immediately service all current academic computing activity at UTC via UTCC.

II. SPECIFIC REQUIREMENTS

A. Primary System Requirements

1. 32 User Interactive BASIC System

The system proposed requires the existence of a full function, well-developed, fully debugged, existing software/hardware combination capable of supporting 32 simultaneously connected and active BASIC users receiving responses in four seconds or less to normal transactions as well as simultaneous concentrator functions for remote job entry through at least 2 card reader/printer stations. Standard ASCII and EBCDIC keyboard devices as well as standard medium speed card readers and printers must be supported as described below.

1-1 The BASIC languages offered by the system must be an extension of Dartmouth BASIC and must include at least matrix operations, character string operations, and disk file support as a minimum extension set. These extensions must form a natural part of the BASIC language.

1-2 Disk storage - It is necessary that an adequate amount of disk storage be provided for residence of the system, user programs, user data, and swap area and contain approximately 30 million 8 bit bytes of storage with an average access time no greater than 25 milliseconds. At least 20 million bytes of disk medium should be physically removable.

1-3 An IBM compatible 9-track (800 or 1600 bpi) tape drive must be supplied as an integral part of the system. Software must be provided which allows the dumping and restoring of all system disks to or from tapes. The selective dumping and restoration of specifically selected files from the disk must also be provided.

1-4 EIA interfaces (RS 232) capable of supporting dial modems as well as modems supporting local loops must be provided. These interfaces must be sufficiently flexible to support modems equivalent to the Bell 113B as well as FDM and TDM type multiplexing equipment. Facility for automatic disconnect originated by the system and/or by the modem must exist. Abortive disconnects must result in the automatic readying of the interface for a new incoming call in approximately two seconds or less.

1-5 The EIA interfaces must support both ASCII and EBCDIC devices. Baud rates of 110, 134.5, 150, 300, 600, 900, and 1200 must be available and these speeds automatically detected and set.

1-6 IBM 2741 type selectric typewriter based terminals and equivalent devices utilizing the same code and conventions supported at 134.5 baud on the same EIA interfaces are desired.

2. HASP Work Station Function

The proposed system must be capable of performing the equivalent function of a HASP Work Station in support of devices such as card readers, printers, etc., when connected to a standard HASP/IBM system utilizing binary synchronous conventions. The purpose of this function is to allow the inputting of jobs for remote entry by means of a card reader attached to the proposed equipment and the securing of remote job output through the printer and other attached devices.

2-1 The binary synchronous interface must be connected through the standard EIA electrical interface operable up to and including 9600 baud over standard communications circuits. Synchronous clocking at a rate including 9600 baud and the optional acceptance of clocking from the communications equipment must be included in the capability of the interface equipment.

2-2 Standard card reader devices for 80 column cards must be attachable and offered by the manufacturer. These devices must operate at a rate of at least 300 cards per minute simultaneously with the operation of the time-sharing system.

2-3 A variety of medium to high speed printers must be available from the manufacturer for attachment. These printers must be able to operate in a multileaving mode simultaneously with the operation of the time-sharing system.

2-4 It is desirable that the system also support simultaneous operation of card readers and printers operating at 100 cards per minute and 100 lines per minute respectively.

2-5 The system should also support digital incremental plotters.

2-6 The attachment of a CRT or teletype console device for control of the HASP work station is required.

2-7 The HASP Work Station function must be capable of transferring files between the IBM system and the BASIC system disk.

3. Communications Processor Function

It is necessary that the keyboard devices attached normally for use with the BASIC processor be provided access through the binary synchronous communications interface to the attached IBM equipment available at UTCC. The function of this interface is to exchange line by line messages between the appropriate devices and the interactive processors (programs) in the IBM system. We specifically wish to interface to the IBM standard TCAM communications access method which is utilized by the TSO time-sharing option of the OS/MVT operating system. If UTK does not implement TCAM, we desire an interface to UTK's UTTSS. It is expected that records passed through this interface would be similar in format to HASP communications records and would be "sorted" for further routing within the 360 equipment by UTCC provided codes which would route the messages to HASP and to TCAM for appropriate handling. Each keyboard device must perform, also, the functions of a HASP work station.

3-1 The communications interface with the IBM equipment for both the HASP and the interactive traffic must be (standard IBM defined) binary synchronous operating at 9600 baud. Operation will be half duplex utilizing full duplex communications facilities.

3-2 Necessary communications flexibility to satisfy the needs of at least the TCAM access method for interactive access to the IBM system must be provided. If TSO is not implemented at UTK, interactive access to UTTSS is needed.

3-3 Communications conventions necessary to satisfy the HASP Work Station interface must be provided.

3-4 The vendor provided system must be capable of discriminating, at user sign-on time, between requests for the manufacturer's BASIC system and requests for access to the IBM system.

3-5 The interface must be capable of a logical disconnect and re-enable sequence.

4. Card Reader

A card reader operating at a rate of at least 600 cards per

minute simultaneously with the operation of the time-sharing system (price this both within the general bid and as an optional item for consideration).

5. Line Printer

A line printer operating at 300 lines per minute, 136 columns, 64 characters, simultaneously with the operation of the time-sharing system (price this both within the general bid and as an optional item for consideration).

B. Software Requirements

1. System Software Tools

All systems software necessary for the BASIC processor and the concentrator functions must be demonstrably stable and compatible with UTC requirements for the functions specified. The manufacturer must supply a "cross-assembler" debugged on the 360 system.

1-1 Software must be available for taking output from the "cross-assembler" and placing it in a format on the 9-track tape for entry into the proposed system.

1-2 A memory dump facility must be provided.

1-3 Debug assistance software must be provided.

1-4 Software must be provided which allows the dumping and restoring of all system disks to or from tapes.

1-5 Selective dumping and restoration of specifically selected files from the disk must be provided.

1-6 A full accounting system for usage statistics must be available.

2. Applications Software

The proposed system must provide a debugged, stable applications software library. Since the proposed system is designed to provide instructional computing in CAI (Computer-Assisted-Instruction) over

and above interactive computing and library programs for higher education, the applications software library must be sophisticated. Further, since the system must be self-operating, this software must be demonstrable and well-supported. Mere reference to software existing on another system is unacceptable.

2-1 At least one CAI Author Language must be provided. This language should be well-attested as to usage and comparable with Course Writer III.

2-2 A statistical package capable of handling data for analysis by advanced methods must be provided. This package must provide power for at least crosstabulations, regression, and multivariate analysis. Verification data for this package should be available.

2-3 A library of applications utilities must be provided.

2-4 An instructional management system for collecting usage data, performing statistical analysis, and allowing long term management of student learning activity must be provided.

2-5 All applications software must have formal documentation.

2-6 Graphics package must be provided to support Tektronic 4000 series terminals as part of overall system.

2-7 Math package for general purpose instructional use must be provided.

C Documentation

The following documentation must be supplied in response to this request.

1. A response to the proposed system according to the guidelines for the State of Tennessee.

2. Hardware Manuals

   Hardware manuals for operation of the proposed system should be sent directly to Dr. L. D. Davis.

3. Software Manuals

   Manuals describing the internal operations and use of systems and applications software as specified should be sent directly to Dr. L. D. Davis.

4. A catalog of library programs must be provided.

D. Other Considerations

1. Maintenance Service

The vendor must offer immediate maintenance for the prime shift of at least 40 hours per week as well as on-call, quick response maintenance for the reminder of the 24 hour day, 7 day week. This service must include all parts and labor as well as preventive maintenance. Extensive diagnostic programs must be included so that a small staff can quickly isolate and repair all reasonably predictable failures. Hardware manuals, logic and wiring diagrams, parts lists, etc., that are adequate for system maintenance must be provided. Service personnel should not be stationed greater than 150 miles from UTC.

2. Price Information

Tennessee Guidelines must be followed. The proposal must contain specific information relative to the purchase or lease-purchase prices and maintenance prices of each separate component of the system as well as any transportation and installation costs associated with the system. All special charges to be associated with the equipment or software or personnel must be enumerated. Any specific prices for software, for software development, for software source, etc., must be enumerated.

For this purpose UTC is to be considered a government owned educational institution.

3. Delivery Schedule

It is essential that all necessary hardware and software be delivered and installed by August 1, 1975 to provide services described in Section A, 1-1 through 1-6 inclusive, 2-1 through 2-7 inclusive, 3-1 through 3-5 inclusive, 4 and 5. Also software referred to in Section B, 1 above, must be provided on this date. Further software, if offered in

response to this request, must be provided no later than January 1, 1976 in a fully debugged, installable form.

4. Demonstrated System Performance

It is essential that two sites offering 32 user interactive BASIC as well as the concentrator functions for educational institutions be demonstrated.

5. Environmental Requirements

Approximate floor space required, electrical power requirements, and other environmental requirements must be stated for the proposed system.

6. Systems Assistance

Specific systems education offered by the vendor related to both system programmer education and user education must be specified. Any costs associated with these must also be enumerated.

7. Quality and Completeness

The overall quality and completeness of the response to this request will be considered in evaluating the proposal.

III. DOCUMENTATION REQUIRED

The following documentation must be supplied in response to this request in order to guarantee complete consideration of the response.

A. Brief, Succinct Proposal

A brief, succinct but detailed response to each item in II-A and II-B is required. This can be supported by other material as desired but the brief proposal should enable a reviewer to learn quickly whether or not a required or desired item is offered and to some extent evaluate any variations that might be offered.

B. Hardware Manuals

Manuals describing the operation of the proposed hardware system from the system's users point of view are required.

C. Software Manuals

Manuals describing the internal operations and use of all proposed software systems must be provided.

D. Time Payment Purchase Agreement

A copy of any proposed time payment purchase agreement must be attached.

Distribution list for UTC request for proposals (BASIC language system) dated April 2, 1975.

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